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The association between driving time and unhealthy lifestyles: A cross-sectional, general population study of 386,493 UK Biobank participants

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ABSTRACT

Background. Driving is a common type of sedentary behaviour; an independent risk factor for poor health. The study explores whether driving is also associated with other unhealthy lifestyle factors.

Methods. In a cross-sectional study of UK Biobank participants, driving time was treated as an ordinal variable and other lifestyle factors dichotomised into low/high risk based on guidelines. The associations were explored using chi-square tests for trend and binary logistic regression.

Results. Of the 386,493 participants who drove, 153,717 (39.8%) drove <1 hour/day; 140,140 (36.3%) 1 hour/day; 60,973 (15.8%) 2 hours/day; and 31,663 (8.2%) ≥3 hours/day. Following adjustment for potential confounders, driving ≥3 hours/day was associated with being overweight/obese (OR 1.74, 95% CI 1.64-1.85), smoking (OR 1.48, 95% CI 1.37-1.63), insufficient sleep (1.70, 95% CI 1.61-1.80), low fruit/vegetable intake (OR 1.26, 95% CI 1.18-1.35) and low physical activity (OR 1.05, 95% CI 1.00-1.11), with dose relationships for the first three, but was not associated with higher alcohol consumption (OR 0.94, 95% CI 0.87-1.02).

Conclusions. Sedentary behaviour, such as driving, is known to have an independent association with adverse health outcomes. It may have additional impact mediated through its effect on other aspects of lifestyle. People with long driving times are at higher risk and might benefit from targeted interventions.

Keywords (MeSH terms)

Automobile driving; Lifestyle, sedentary; Diet; Smoking; Obesity; Sleep; Alcohol drinking

Introduction

Sedentary behaviour can co-exist with high levels of physical activity and is independently associated with deleterious health outcomes including: diabetes, cardiovascular disease, cancer, and all-cause mortality.[1-3] The guidelines in the United Kingdom (UK) have been revised to recommend that, in addition to undertaking physical activity, people should avoid sitting for extended periods of time and break up periods of sitting with standing or light activity.[4] Driving time is an important contributor to overall sedentary behaviour and has increased over time.[5] More than half of the population of England and Wales now drive to work,[6] and the number of miles travelled on the road increased from 37 to 311 billion between 1951 and 2014.[7] Unlike many types of sedentary behaviour, driving occurs outside the home and, thus, may be more amenable to change through policy or environmental interventions.[2]

In addition to its direct association with health, sedentary behaviour may indirectly impact other lifestyle behaviours.[8] Studies, to date, have tended to focus on total sedentary time or computer/television screen-related sedentary time.[8] The limited evidence suggests that different types of sedentary behaviour vary in the extent to which they cluster with other lifestyle behaviours.[8] There is, currently, a paucity of research into the relationship between driving time and other aspects of lifestyle.

In spite of guidelines produced by the World Health Organization and interventions, 33% of adults fail to meet physical activity guidelines, 19% of men still smoke and 68% are obese or overweight.[9] Understanding the contexts that influence these behaviours and the

sub-groups of society at highest risk can help in designing and targeting more effective interventions.

Methods

Study design, data source and inclusion criteria

A cross-sectional study was undertaken using baseline data from UK Biobank. Between 2006 and 2010, UK Biobank recruited just over 500,000 people, aged 40 to 69 years, from the general population via 22 assessment centres across the UK. Participants provided data on typical daily driving time, smoking status, alcohol consumption, physical activity, diet and sleep via a self-completed, touch-screen questionnaire.[10] Participants were excluded from this study if they did not drive (n=106,197) or had missing or implausible (>24 hours/day) data (n=9,953), producing a study population of 386,493.

Data variables

Daily driving time was categorised into four groups: <1 hour, 1 hour, 2 hours, ≥3 hours. Self-reported smoking was categorised as current or non (ex or former) smoker and alcohol consumption as >14 units/week or ≤14 units.[11] Participants reported their duration and frequency of moderate and vigorous physical activity based on the questions in the International Physical Activity Questionnaire. This information was converted into metabolic equivalents (MET) and dichotomised into inadequate (<600 MET minutes/week) and adequate (≥600 MET minutes/week) levels of physical activity. The latter equates to at least 150 minutes of moderate physical activity or 75 minutes of vigorous physical activity per week.[12] The touchscreen food frequency questionnaire was used to categorise participants into those who consumed <5 portions per day of fresh/dried fruit, cooked/raw vegetables or salad and those who consumed ≥5.[13] Participants were also

invited to complete up to five 24-hour dietary recall questionnaires on-line. The first of which was administered at the end of the baseline assessment followed by a further four conducted between February 2011 and April 2012.[14] Mean daily energy intake was calculated from the surveys completed by participants and categorised into >10,500 kJ or ≤10,500 kJ for men, and >8,400 kJ or ≤8,400 kJ for women.[15] Typical daily sleep was dichotomised into inadequate (<7 hours/day) and adequate (≥7 hours/day).[16] Body mass index (BMI) was calculated using weight and height measurements obtained by trained staff. Weight was measured using the Tanita BC-418MA body composition analyser and height measured using the Seca 202 height measure.[17] BMI was used to dichotomise participants into overweight/obese (BMI >25 kg/m^2) or not (BMI ≤25 kg/m^2).[18]

Statistical analyses

The characteristics and health behaviours of participants were compared by driving time using chi square test for trend for binary variables, Spearman's rank order correlation for other categorical variables, and the Kruskal Wallis test for trend for continuous variables. A series of binary logistic regression models were run with the lifestyle factors (smoking status; alcohol intake; adiposity; physical activity; sleep duration) as the dependent variables. The models were run univariately with driving time as the explanatory variable and <1 hour/day treated as the referent category. The models were then re-run multivariately. Age, sex, ethnicity and socioeconomic deprivation were all associated with both driving time and the other lifestyle factors and, therefore, were included in the models as potential confounders.

The individual measures of socioeconomic status were annual, household, pre-tax income and highest qualification and area deprivation was measured using the Townsend index which is derived from household ownership, car ownership, overcrowding and unemployment.[19] Finally the multivariate models were re-run including potential mediators: the other lifestyle factors as well as mean total energy intake, screen-related sedentary behaviour time and self-reported overall health (categorised as excellent, good, fair or poor). For each model the Hosmer-Lemeshow statistic was derived to check fit. All data analyses were undertaken using STATA v14.

Ethics

This study was conducted under generic approval from the NHS National Research Ethics Service (approval letter dated 17 June 2011, ref 11/NW/0382) and was part of project number 7155.

Results

Of the 502,643 UK Biobank participants, 9,953 did not provide data on driving time and 106,197 did not drive; therefore, the study population was 386,493. Of these, 153,717 (39.8%) drove <1hour/day, 140,140 (36.3%) 1 hour/day, 60,973 (15.8%) 2 hours/day and 31,663 (8.2%) ≥3 hours/day. The median age of the sample was 58 years (IQR 13) and 51% were female. The distribution of driving time differs between men and women. Among men, 33% drive <1hour, 36% 1-2 hours, 18% 2-3 hours and 12% for 3 hours and more. Among women, these figures are 46%, 36%, 13% and 4%, respectively.

Participants who spent more time driving were: more likely to be male, non-white and socioeconomically deprived; less likely to meet guidelines on smoking, alcohol intake, adiposity, physical activity, and sleep duration; and more likely to rate their overall health as fair or poor (Table 1). Their overall energy consumption was lower but they were less likely to meet the guidelines on fruit and vegetable intake (Table 1). They also spent more time in screen-related sedentary behaviour (Table 1).

There was a dose-dependent relationship between driving time and both smoking and adiposity that persisted after adjustment for potential confounders (Table 2). In the multivariate models, there was also a clear dose relationship with short sleep duration (Table 2). Long driving times (≥3 hours/day) were associated with low physical activity and low consumption of fruit and vegetables, even after adjustment for potential confounders, but there was no evidence of a dose relationship (Table 2). In the final model, inclusion of energy consumption, physical activity and sleep duration attenuated the association between driving time and adiposity. On univariate analysis, long driving times were associated with higher alcohol consumption but, once potential confounders had been taken into account, the relationship reversed. There was suggestion of a negative dose-dependent relationship whereby longer driving times were associated with lower alcohol consumption; however, this did not reach statistical significance (Table 2). There were statistically significant interactions with sex for the associations between driving time and smoking ($p<0.001$) and BMI ($p<0.001$). There was a stronger dose-dependent relationship between driving time and smoking for female than male drivers, while there was a weaker dose-dependent relationship between driving time and adiposity for female than male drivers (Supplementary Table 1). There were also statistical interactions (all $p<0.001$) with age for the associations between driving time and all lifestyle factors (Table 3). The dose-

dependent relationships between driving time and both smoking and adiposity were stronger with increasing age, while driving times was only associated with alcohol consumption in those aged 37-57 years. In a sensitivity, we excluded the 16,970 participants that drove more than 3 hours daily. This did not alter the overall findings of the study (Supplementary Table 2).

Discussion

Main findings of this study

People with long driving times were less physically active and spent more time watching television or using computers; another type of sedentary behaviour. They were also more likely to have other lifestyle risk factors such as smoking, adiposity, low consumption of fruit and vegetables, and short sleep duration. The strength of some associations differed by age and sex, with older drivers at higher risk of smoking and adiposity. The association between driving time and adiposity appeared to be partly mediated by energy consumption, physical activity and sleep duration. The only exception to unhealthy lifestyles was alcohol intake where, presumably as a result of drink-drive legislation, people with long driving times were more likely to meet guidelines after taking into account their age, sex and level of socioeconomic deprivation. Overall, people with long driving times are a high risk group who might benefit from targeted health-promotion interventions.

What is already known on this topic

The majority of research, to date, has focused on either screen-related or total sedentary behaviour; of the 74 studies identified in a recent systematic review,[8] only six measured transport-related sedentary behaviour and only two of these measured driving time specifically.[20,21] Furthermore, only one examined the associations between driving time and a range of lifestyle factors.[20] This is important because different types of sedentary behaviours do not necessarily have the same associations with other unhealthy behaviours. Television viewing is strongly associated with smoking and poor diet but these behaviours can occur concurrently and may be a direct response to advertising or portrayal of the activity on television.[22] Therefore, research into screen-related sedentary behaviour may not be generalizable to other types. Also, some sedentary behaviours, such as driving, may be more amenable to policy and environmental interventions.[23] For example, the ready accessibility of unhealthy snacks and cigarettes at petrol stations may contribute to the unhealthy lifestyles of drivers.[24]

Previous studies have tended to include driving time in total transport-related sedentary behaviour or total travel time. However, driving differs from being a passenger or using public transport in important ways. Use of public transport expends more energy than car use,[25] and driving is associated with more stress and anxiety than using public transport or being a passenger.[26] It has been postulated that the adverse psychological effects of driving mediate its association with unhealthy lifestyle choices.[20,27] The alternative mechanism mooted is that the time spent driving is simply not available for sleeping, physical activity and cooking; the time-displacement theory.[20,27,28]

This study is 10-fold larger than the only previous study to have explored the association between driving time and a range of other lifestyle behaviours.[20] The results, obtained on

an Australian population, were generally consistent with ours; compared with people who drove 30 minutes per day or less, those who drove for at least two hours were more likely to: smoke (OR 1.73, 95% CI 1.43-2.09); be physically inactive (OR 1.57, 95% CI 1.41-1.74); be obese (OR 1.78, 95% CI 1.61-1.97); and have short sleep duration (OR 1.86, 95% CI 1.67-2.07) after adjusting for sociodemographic confounders, with dose relationships reported for each of these measures. In that study, the positive association with alcohol intake became negative following adjustment but failed to reach statistical significance; consistent with our findings. Their findings on fruit and vegetable intake also did not reach statistical significance. Ding et al. reported that participants who drove for more than 2 hours daily were less likely to sit for more than 8 hours. This is contrary to the existing literature, including our study, which suggests that sedentary behaviours tend to cluster.

What this study adds

This is only the second study to investigate the association between driving time and a range of lifestyle factors, and the largest study to date by far. The study population was recruited from the general population across the UK. BMI was based on actual measurements compared with self-reported height and weight used in the study by Ding et al.[20] We were able to adjust for a range of potential confounders and mediators and explore dose-relationships. The study by Ding et al. had data on physical activity, diet and sleep but did not examine whether they mediated the association with obesity.[20]

Limitations of this study

In common with the previous study by Ding et al.,[20] this study is cross-sectional. Therefore, a temporal relationship cannot be established, causation cannot be inferred, and

reverse causation cannot be excluded. We adjusted for a range of potential confounders but, as with any observational study, residual confounding is possible. Whilst objective measurement of BMI was a strength the other lifestyle factors were based on self-reported which may result in random or systematic error. We were able to measure driving time, rather than travel time, but did not have the data to differentiate between one long trip and multiple short trips. The data collected by UK Biobank did not differentiate between leisure, commuting and occupational driving. However, our findings were not materially altered following exclusion of participants who drove more than 3 hours daily; who are highly likely to be occupational drivers. Therefore, the findings are unlikely to be due simply to reason for driving. Reducing the number of long journeys driven may not be possible, especially for occupational drivers. However, all drivers (social, commuter and occupational), as well as employers and policy makers, should be made aware of the possibility that long journeys may impact indirectly on health by encouraging adoption of other unhealthy lifestyle factors.

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References

1. Owen N, Healy GN, Matthews CE, Dunstan DW. Too Much Sitting: The Population-Health Science of Sedentary Behavior. Exercise and Sport Sciences Reviews. 2010; 38:105-13.
2. Wilmot EG, Edwardson CL, Achana FA, Davies MJ, Gorely T, Gray LJ, et al. Sedentary time in adults and the association with diabetes, cardiovascular disease and death: systematic review and meta-analysis. Diabetologia. 2012; 55:2895-90.
3. Biswas A, Oh PI, Faulkner GE, Bajaj RR, Silver MA, Mitchell MS, et al. Sedentary time and its association with risk for disease incidence, mortality, and hospitalization in adults: a systematic review and meta-analysis. Annals of internal medicine. 2015; 162:123-32.
4. Department of Health Social Services and Public Safety. Physical activity guidelines for adults (19-64 years), Factsheet 4 – Physical activity guidelines. Available at: https://www.nhs.uk/Livewell/fitness/Documents/adults-19-64-years.pdf (Accessed: 14 February 2018).
5. Prince SA, Reed JL, McFetridge C, Tremblay MS, Reid RD. Correlates of sedentary behaviour in adults: a systematic review. Obesity reviews : an official journal of the International Association for the Study of Obesity. 2017; 18:915-35.
6. The Office for National Statistics. Census reveals details of how we travel to work in England and Wales. Available at: https://webarchive.nationalarchives.gov.uk/20160105160709/http:/www.ons.gov.uk/ons/rel/mro/news-release/travel-to-work/census-reveals-details-of-how-we-travel-to-work-in-england-and-wales.html (Accessed: 14 February 2018).

7. Department for Transport. Road Use Statistics Great Britain 2016. Available at: https://www.licencebureau.co.uk/wp-content/uploads/road-use-statistics.pdf (Accessed: 14 February 2018)
8. O'Donoghue G, Perchoux C, Mensah K, Lakerveld J, van der Ploeg H, Bernaards C, et al. A systematic review of correlates of sedentary behaviour in adults aged 18-65 years: a socio-ecological approach. BMC Public Health. 2016; 16:163.
9. The Office for National Statistics. Health Survey for England 2016: Summary of key findings. Available at: https://digital.nhs.uk/catalogue/PUB22610 (Accessed 14 February 2018)
10. UK Biobank. Protocol for a large-scale prospective epidemiological resource. Protocol No. UKBB-PROT-09-06 (Main phase). Stockport. 2007. Available at: http://www.ukbiobank.ac.uk/wp-content/uploads/2011/11/UK-Biobank-Protocol.pdf. (Accessed 17 April 2017)
11. NHS Choices. Alcohol units, NHS Choices. 2015. Available at: http://www.nhs.uk/Livewell/alcohol/pages/alcohol-units.aspx (Accessed: 14 February 2018).
12. World Health Organisation. Global recommendations on physical activity for health. Available at: http://apps.who.int/iris/bitstream/10665/44399/1/9789241599979_eng.pdf. (Accessed: 14 February 2018)
13. Public Health England.The Eatwell Guide. 2016 Available at: https://www.gov.uk/government/publications/the-eatwell-guide (Accessed: 12 February 2018).
14. UK Biobank. Questionnaires Participants. Available at: http://www.ukbiobank.ac.uk/questionnaires-participants/.. Accessed: 19 April 2017.

15. NHS Choices. Understanding calories. Available at: http://www.nhs.uk/Livewell/loseweight/pages/understanding-calories.aspx (Accessed: 14 February 2018).
16. Hirshkowitz M, Whiton K, Albert SM, Alessi C, Bruni O, DonCarlos L, et al. National Sleep Foundation's sleep time duration recommendations: methodology and results summary. Sleep health. 2015; 1:40-3.
17. UK Biobank. Baseline assessment 2006-2010. Available at http://www.ukbiobank.ac.uk/background-to-the-project/. (Accessed: 10 January 2017).
18. National Institute for Health and Care Excellence. Obesity: Identification, assessment and management. 2014. Available at: https://www.nice.org.uk/guidance/cg189/chapter/1-recommendations#surgical-interventions. (Accessed: 14 February 2018)
19. ReStore National Centre for Research. Geographical Referencing Learning Resource Available at: http://www.restore.ac.uk/geo-refer/36229dtuks00y19810000.php (Accessed: 5 May 2017).
20. Ding D, Gebel K, Phongsavan P, Bauman AE, Merom D. Driving: A Road to Unhealthy Lifestyles and Poor Health Outcomes. PloS one. 2014; 9:e94602
21. Stamatakis E, Grunseit AC, Coombs N, Ding D, Chau JY, Phongsavan P, et al. Associations between socio-economic position and sedentary behaviour in a large population sample of Australian middle and older-aged adults: The Social, Economic, and Environmental Factor (SEEF) Study. Prev Med. 2014; 63:72-80.
22. Grothe KB, Roach J, Low A, Himes S, Craft JM, Norman GJ, et al. Sedentary behavior and food cravings in diverse overweight women: a pilot study. Women & health. 2013; 53:405-18

23. van Uffelen JG, Heesch KC, Brown W. Correlates of sitting time in working age Australian women: who should be targeted with interventions to decrease sitting time? Journal of physical activity & health. 2012; 9:270-87.

24. Jack FR, Piacentini MG, Schroder MJ. Perception and role of fruit in the workday diets of Scottish lorry drivers. Appetite. 1998; 30:139-49.

25. Costa S, Ogilvie D, Dalton A, Westgate K, Brage S, Panter J. Quantifying the physical activity energy expenditure of commuters using a combination of global positioning system and combined heart rate and movement sensors. Prev Med. 2015; 81:339-44.

26. Wener RE, Evans GW. Comparing stress of car and train commuters. Transportation Research Part F: Traffic Psychology and Behaviour. 2011; 14:111-6.

27. Yang J, French S. The Travel—Obesity Connection: Discerning the Impacts of Commuting Trips with the Perspective of Individual Energy Expenditure and Time Use. Environment and Planning B: Planning and Design. 2013; 40:617-29.

28. Swanson KC, McCormack GR. The relations between driving behavior, physical activity and weight status among Canadian adults. Journal of physical activity & health. 2012; 9:352-9.

Table 1. Sociodemographic and lifestyle characteristics of participants by typical daily driving time

	<1hr N=153,717	1hr N=140,140	2hrs N=60,973	≥3hrs N=31,663
	Median (IQR)	Median (IQR)	Median (IQR)	Median (IQR)
Age (years)	59 (12)	57 (13)	55 (13)	54 (13)
	N (%)	N (%)	N (%)	N (%)
Sex				
Male	62,611 (41)	68,882 (49)	34,653 (57)	23,559 (74)
Female	91,106 (59)	71,258 (51)	26,320 (43)	8,104 (26)
Ethnicity				
White	148,437 (97)	134,217 (96)	57,442 (94)	28,976 (92)
Asian	1,979 (1)	2,377 (2)	1,287 (2)	952 (3)
Black	946 (1)	1,344 (1)	1,062 (2)	1,008 (3)
Chinese	419 (0)	366 (0)	171 (0)	88 (0)
Other	778 (1)	843 (1)	49 (1)	312 (1)
Mixed	672 (0)	658 (0)	357 (1)	223 (1)
Missing	486	335	181	104
Townsend deprivation index quintile				
1	36,392 (24)	33,452 (24)	13,551 (22)	5,718 (18)
2	34,907 (23)	32,087 (23)	13,159 (22)	5,974 (19)
3	32,614 (21)	30,059 (21)	12,868 (21)	6,493 (21)
4	29,573 (19)	25,965 (19)	11,993 (20)	6,513 (21)
5	20,073 (13)	18,411 (13)	9,228 (15)	6,906 (22)
Missing	158	166	114	59
Household annual income (£)				
<18,000	24,956 (19)	22,913 (19)	8,196 (15)	4,361 (16)
18,000-30,000	35,832 (27)	30,887 (25)	11,696 (22)	7,159 (26)
31,000-51,000	36,270 (27)	33,676 (28)	15,481 (29)	8,660 (32)
52,000-100,000	27,629 (21)	27,357 (22)	14,421 (27)	6,137 (22)
>100,000	7,939 (6)	7,067 (6)	3,699 (7)	1,157 (4)
Missing	21,091	18,240	7,480	4,189
Highest qualification				
Degree	59,776 (44)	45,348 (39)	19,748 (39)	6,161 (25)
School	58,802 (44)	54,480 (46)	23,095 (45)	13,210 (54)
HNC/HND	7,788 (6)	9,818 (8)	5,003 (10)	3,262 (13)
Other	8,210 (6)	7,710 (7)	3,410 (7)	1,665 (7)
Missing	19,141	22,784	9,717	7,365
Smoking status				
Current	11,539 (8)	13,068 (9)	6,544 (11)	4,701 (15)
Non	142,112 (92)	127,011 (91)	54,405 (89)	26,941 (85)
Missing	66	61	24	21
Alcohol consumption (units/week)				
>14	18,834 (39)	16,990 (41)	7,371 (42)	5,311 (43)
≤14	29,044 (61)	24,871 (59)	10,249 (58)	5,311 (57)
Missing	105,839	98,279	43,353	22,382
Body mass index (kg/m^2)				
≥25	94,431 (62)	94,975 (69)	43,765 (73)	24,891 (80)
<25	56,858 (38)	42,776 (31)	16,104 (27)	6,227 (20)
Missing	2,428	2,389	1,104	545
Physical activity (MET mins/week)				
<600	69,151 (45)	61,565 (44)	27,900 (46)	14,751 (47)
≥600	84,566 (55)	78,575 (56)	33,073 (54)	16,912 (53)
Sleep (hours/day)				

<7	31,969 (21)	33,188 (24)	16,807 (28)	10,083 (32)
≥7	121,748 (79)	106,951 (76)	44,166 (72)	21,580 (68)
Missing	0	1	0	0
Fruit and vegetable intake (portions/day)				
<5	15,518 (13)	20,226 (16)	9,580 (18)	6,218 (23)
≥5	106,492 (87)	102,681 (84)	43,123 (82)	20,982 (77)
Missing	31,707	17,233	8,270	4,463
Total energy intake (kJ/day)				
≥10,500 (M) ≥8,400 (F)	29,172 (38)	22,231 (38)	8,542 (36)	3,627 (35)
<10,5000 (M) <8,400 (F)	47,890 (62)	36,875 (62)	15,383 (64)	6,832 (65)
Missing	76,655	81,034	37,048	21,204
Screen-related sedentary behaviour (hours/day)				
>5.0	24,184 (16)	24,189 (18)	10,752 (18)	6,102 (20)
4.0-5.0	43,355 (29)	45,248 (33)	18,151 (30)	9,993 (32)
3.0-3.5	34,055 (23)	31,480 (23)	13,451 (22)	6,713 (22)
<3.0	49,722 (33)	37,122 (27)	17,509 (29)	8,091 (26)
Missing	2,401	2,101	1,110	764
Overall health				
Poor	4,888 (3)	4,859 (3)	2,132 (4)	1,308 (4)
Fair	26,273 (17)	27,510 (20)	13,007 (21)	8,078 (26)
Good	92,187 (60)	83,614 (60)	35,918 (59)	18,089 (57)
Excellent	29,921 (20)	23,783 (17)	9,705 (16)	4,054 (13)
Missing	488	374	211	134

All $p<0.001$

N number; IQR interquartile range; HNC higher national diploma/certificate; HND higher national diploma; M male; F female

Table 2. Binary logistic regression analyses of the associations between typical daily driving time and lifestyle factors.

		Driving time (hours/day)						
		<1	1		2		≥3	
		OR	OR	95% CI	OR	95% CI	OR	95% CI
Current smoker								
	Univariate	1.00	1.27	1.23-1.30	1.48	1.43-1.53	2.15	2.07-2.23
	Multivariate[1]	1.00	1.16	1.12-1.20	1.27	1.23-1.32	1.50	1.43-1.57
	Multivariate[2]	1.00	1.15	1.09-1.22	1.28	1.19-1.37	1.48	1.37-1.63
Alcohol consumption								
	Univariate	1.00	1.05	1.03-1.08	1.11	1.07-1.15	1.15	1.10-1.21
	Multivariate[1]	1.00	0.99	0.95-1.02	0.96	0.92-1.00	0.93	0.87-0.98
	Multivariate[2]	1.00	0.98	0.94-1.02	0.98	0.93-1.04	0.94	0.87-1.02
Body mass index								
	Univariate	1.00	1.34	1.32-1.36	1.64	1.60-1.67	2.41	2.34-2.48
	Multivariate[1]	1.00	1.29	1.26-1.31	1.54	1.50-1.58	1.93	1.86-2.00
	Multivariate[2]	1.00	1.24	1.21-1.28	1.43	1.37-1.49	1.74	1.64-1.85
Physical activity								
	Univariate	1.00	0.96	0.94-0.97	1.03	1.01-1.05	1.07	1.04-1.09
	Multivariate[1]	1.00	0.98	0.97-1.00	1.08	1.06-1.11	1.09	1.06-1.12
	Multivariate[2]	1.00	0.97	0.94-0.99	1.08	1.04-1.12	1.05	1.00-1.11
Sleep duration <7 hours								
	Univariate	1.00	1.18	1.16-1.20	1.45	1.42-1.48	1.78	1.73-1.83
	Multivariate[1]	1.00	1.19	1.16-1.21	1.46	1.42-1.50	1.66	1.61-1.72
	Multivariate[2]	1.00	1.16	1.13-1.20	1.44	1.38-1.50	1.70	1.61-1.80
Fruit and vegetables								
	Univariate	1.00	1.35	1.32-1.38	1.52	1.48-1.57	2.03	1.97-2.10
	Multivariate[1]	1.00	1.19	1.16-1.22	1.19	1.15-1.23	1.32	1.26-1.37
	Multivariate[2]	1.00	1.16	1.12-1.21	1.13	1.07-1.19	1.26	1.18-1.35

OR odds ratio; CI confidence interval
[1]adjusted for age, sex, ethnicity, area and individual deprivation
[2]also adjusted for smoking status, alcohol intake, overweight/obese, total energy intake, fruit/vegetable intake, sleep duration, physical activity, screen-related sedentary behaviour and self-reported overall health (where these are not the dependent variable)

Table 3. Binary logistic regression analyses of the associations between typical daily driving time and lifestyle factors by age –multivariate only.

		Driving time (hours/day)						
		<1	1		2		≥3	
		OR	OR	95% CI	OR	95% CI	OR	95% CI
Current smoker								
	37-46	1.00	1.15	1.02-1.29	1.20	1.04-1.37	1.44	1.22-1.71
	47-57	1.00	1.14	1.05-1.25	1.26	1.13-1.40	1.52	1.33-1.73
	58-66	1.00	1.20	1.09-1.32	1.56	1.36-1.78	1.81	1.50-2.17
	67+	1.00	1.11	0.87-1.14	1.18	0.78-1.79	1.84	0.98-3.44
Alcohol consumption								
	37-46	1.00	1.13	1.01-1.26	1.15	1.01-1.32	1.33	1.11-1.59
	47-57	1.00	1.01	0.93-1.08	1.16	1.06-1.26	1.22	1.08-1.38
	58-66	1.00	1.07	1.00-1.14	1.06	0.96-1.17	1.10	0.94-1.28
	67+	1.00	0.94	0.82-1.08	0.87	0.68-1.13	1.05	0.64-1.72
Body mass index								
	37-46	1.00	1.27	1.18-1.36	1.47	1.35-1.60	1.98	1.78-2.24
	47-57	1.00	1.25	1.19-1.30	1.49	1.40-1.58	1.96	1.79-2.14
	58-66	1.00	1.33	1.27-1.39	1.64	1.52-1.77	2.34	2.07-2.66
	67+	1.00	1.41	1.27-1.56	1.88	1.53-2.30	2.63	1.71-4.03
Physical activity								
	37-46	1.00	0.88	0.82-0.95	0.94	0.86-1.02	0.86	0.77-0.97
	47-57	1.00	0.99	0.95-1.04	1.07	1.01-1.13	0.96	0.89-1.04
	58-66	1.00	0.96	0.92-1.00	1.16	1.09-1.24	1.16	1.05-1.29
	67+	1.00	0.84	0.76-0.93	0.76	0.64-0.91	1.33	0.96-1.84
Sleep duration <7 hours								
	37-46	1.00	1.17	1.08-1.28	1.48	1.34-1.64	1.76	1.64-2.10
	47-57[1]	1.00	1.14	1.08-1.20	1.40	1.31-1.49	1.60	1.47-1.74
	58-66	1.00	1.20	1.14-1.26	1.50	1.39-1.62	1.74	1.56-1.94
	67+	1.00	1.13	1.00-1.27	1.07	0.87-1.33	1.16	0.79-1.71
Fruit and vegetables								
	37-46	1.00	1.24	1.14-1.35	1.22	1.10-1.35	1.34	1.18-1.52
	47-57	1.00	1.19	1.12-1.27	1.28	1.18-1.38	1.55	1.41-1.71
	58-66	1.00	1.22	1.14-1.30	1.17	1.05-1.30	1.70	1.48-1.96
	67+	1.00	1.26	1.07-1.47	1.04	0.77-1.39	1.53	0.96-2.44

OR odds ratio; CI confidence interval
Analysis was adjusted for age, sex, ethnicity, area and individual deprivation, smoking status, alcohol intake, overweight/obese, total energy intake, fruit/vegetable intake, sleep duration, physical activity, screen-related sedentary behaviour and self-reported overall health (where these are not the dependent variable)

Supplementary Table 1. Binary logistic regression analyses of the associations between typical daily driving time and lifestyle factors by sex.

		Driving time (hours/day)						
		<1	1		2		≥3	
		OR	OR	95% CI	OR	95% CI	OR	95% CI
Current smoker								
Women								
	Univariate	1.00	1.28	1.24-1.33	1.52	1.45-1.60	2.15	2.01-2.31
	Multivariate[1]	1.00	1.21	1.16-1.27	1.36	1.28-1.44	1.67	1.53-1.82
	Multivariate[2]	1.00	1.23	1.14-1.33	1.49	1.34-1.65	1.97	1.67-2.29
Men								
	Univariate	1.00	1.18	1.14-1.23	1.32	1.27-1.38	1.83	1.75-1.91
	Multivariate[1]	1.00	1.10	1.05-1.15	1.20	1.14-1.26	1.42	1.34-1.51
	Multivariate[2]	1.00	1.07	0.99-1.15	1.11	1.01-1.22	1.28	1.15-1.43
Body mass index								
Women								
	Univariate	1.00	1.20	1.18-1.22	1.35	1.31-1.39	1.67	1.59-1.75
	Multivariate[1]	1.00	1.24	1.21-1.27	1.44	1.39-1.49	1.76	1.66-1.86
	Multivariate[2]	1.00	1.20	1.15-1.24	1.35	1.28-1.42	1.55	1.41-1.71
Men								
	Univariate	1.00	1.39	1.35-1.42	1.65	1.60-1.70	2.12	2.04-2.21
	Multivariate[1]	1.00	1.37	1.33-1.41	1.66	1.60-1.72	2.07	1.97-2.17
	Multivariate[2]	1.00	1.32	1.27-1.38	1.54	1.45-1.64	1.91	1.76-2.08

OR odds ratio; CI confidence interval
[1]adjusted for age, sex, ethnicity, area and individual deprivation
[2]also adjusted for smoking status, alcohol intake, overweight/obese, total energy intake, fruit/vegetable intake, sleep duration, physical activity, screen-related sedentary behaviour and self-reported overall health (where these are not the dependent variable)

Supplementary Table 2. Sensitivity analysis -Binary logistic regression analyses of the associations between typical daily driving time and lifestyle factors, excluding those that drive > 3hours/day.

		Driving time (hours/day)						
		<1	1		2		>3	
		OR	OR	95% CI	OR	95% CI	OR	95% CI
Current smoker								
	Univariate	1.00	1.27	1.23-1.30	1.48	1.43-1.53	1.81	1.72-1.91
	Multivariate[1]	1.00	1.16	1.12-1.20	1.27	1.23-1.32	1.38	1.29-1.47
	Multivariate[2]	1.00	1.15	1.09-1.22	1.28	1.19-1.37	1.46	1.30-1.64
Alcohol consumption								
	Univariate	1.00	1.05	1.03-1.08	1.11	1.07-1.15	1.11	1.04-1.18
	Multivariate[1]	1.00	0.99	0.95-1.02	0.96	0.92-1.00	0.90	0.83-0.97
	Multivariate[2]	1.00	0.98	0.94-1.02	0.98	0.93-1.04	0.91	0.81-1.01
Body mass index								
	Univariate	1.00	1.34	1.32-1.36	1.64	1.60-1.67	2.11	2.02-2.19
	Multivariate[1]	1.00	1.29	1.26-1.31	1.54	1.50-1.58	1.87	1.78-1.96
	Multivariate[2]	1.00	1.24	1.21-1.28	1.43	1.37-1.49	1.69	1.56-1.84
Physical activity								
	Univariate	1.00	0.96	0.94-0.97	1.03	1.01-1.05	1.07	1.03-1.10
	Multivariate[1]	1.00	0.98	0.97-1.00	1.08	1.06-1.11	1.10	1.06-1.15
	Multivariate[2]	1.00	0.97	0.94-0.99	1.08	1.04-1.12	1.10	1.02-1.18
Sleep duration <7 hours								
	Univariate	1.00	1.18	1.16-1.20	1.45	1.42-1.48	1.71	1.65-1.78
	Multivariate[1]	1.00	1.19	1.16-1.21	1.46	1.42-1.50	1.65	1.58-1.73
	Multivariate[2]	1.00	1.16	1.13-1.20	1.44	1.38-1.50	1.67	1.55-1.80
Fruit and vegetables								
	Univariate	1.00	1.35	1.32-1.38	1.52	1.48-1.57	1.86	1.78-1.95
	Multivariate[1]	1.00	1.19	1.16-1.22	1.19	1.15-1.23	1.32	1.25-1.39
	Multivariate[2]	1.00	1.16	1.12-1.21	1.13	1.07-1.19	1.25	1.14-1.37

OR odds ratio; CI confidence interval; [1]adjusted for age, sex, ethnicity, area and individual deprivation
[2]also adjusted for smoking status, alcohol intake, overweight/obese, total energy intake, fruit/vegetable intake, sleep duration, physical activity, screen-related sedentary behaviour and self-reported overall health (where these are not the dependent variable)